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DIVISIONAL ELECTRONIC WARFARE COMBAT (DEWCOM) MODEL. EXECUTIVE --ETC(U)
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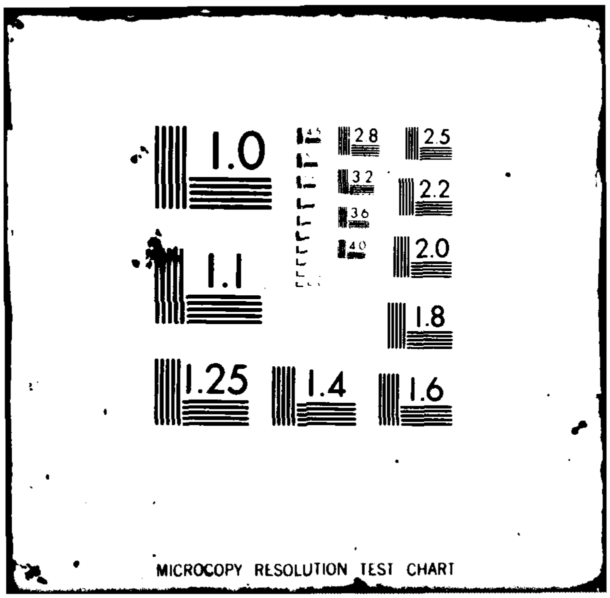
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Commander
US Army Concepts Analysis Agency
ATTN: Systems Force Mix Directorate
8120 Woodmont Avenue
Bethesda, Maryland 20014

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This document is a manual designed to summarize the operational features of the Divisional Electronic Warfare Combat (DEWCOM) computer simulation model. The manual was prepared by C.A.C.I., Inc.-Federal under contract to the US Army Concepts Analysis Agency. The DEWCOM Model is a two-sided stochastic combat simulation model which focuses upon tactical communications and electromagnetic intelligence/threat acquisition systems and the electronic warfare (EW) directed against those systems. To accomplish this, the model is driven by a conventional tactical engagement between a blue maneuver force and a red maneuver force.

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Each side consists of realistically deployed ground and close air support forces that include maneuver units, EW units, artillery units, and support units. The tactical war is driven by a set of orders that may direct units to attack, defend, move, delay or withdraw. As units begin to take tactical actions, messages are triggered which are transmitted over explicitly modeled communication links. The successful completion of these message transmissions is necessary for units to respond in the desired manner. Intelligence is gathered through direct observation of units in contact, radars, and from messages that flow between units. Increases in intelligence can in turn cause messages to be generated which may be sensed or acted upon. As messages are being transmitted over the communications facilities of one side, they are subject to being sensed by the opposing side. Several possible actions may be taken by a side upon becoming aware of the messages of the other side. The messages may be jammed, intercepted, the originator may be located, or no action at all may be taken. Intercepting a message or locating a transmitter allows an increase in the knowledge or intelligence. The model is run as a pure simulation for about 8 to 12 simulated combat hours.

DIVISIONAL ELECTRONIC WARFARE COMBAT (DEWCOM) MODEL

EXECUTIVE SUMMARY

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1.0 INTRODUCTION

1.1. General

This report summarizes the results of the work performed by CACI under contract DAAK 21-79-C-0057 for the Systems Force Mix Directorate of the US Army Concepts Analysis Agency (CAA), viz., developing the Divisional Electronic Warfare Combat (DEWCOM) Model. The contract was awarded on 4 April 1979 and work was completed 3 July 1980 with the installation and satisfactory demonstration of the model on the CAA UNIVAC 1108 computer.

The development resulted in a model written in the SIMSCRIPT II.5 simulation language and encompassed two basic efforts; the redesign of the Communications Electronic Model, Version II.5 (COMMEL II.5) and the inclusion of enhancements to the COMMEL II.5 Model. The DEWCOM Model documentation consists of four volumes:

Executive Summary - an overview of the model (CAA-D-80-5).

DEWCOM User Manual - information on the use of the model including preparation of input data and instructions on analysis of outputs (CAA-D-80-6).

DEWCOM Programmer Manual - information on the model code and operating instructions (CAA-D-80-7).

DEWCOM System Manual - information on the model design (CAA-D-80-8).

1.2 Development History

The DEWCOM Model has its roots in the Signal Corps Ground Combat Simulator which was developed in the early 1960s. That model's purpose was to provide a research tool for Communications-Electronics Combat Development planners, scientists, engineers, systems designers, and operations personnel to use in the study, analysis, organization, development, and implementation of future Communications-Electronics concepts and systems for army combat organizations below field army in size. The simulator was written in the FORTRAN language and operated on the IBM 709 a (then) large-scale (vacuum tube) computer system. It could also be operated on the 709's successor, the transistorized IBM 7090. In the late 1960s this model was redesigned so that it could be used on a CDC 3300 computer. The revision was named the Communications-Electronics (COMMEL) Model. Like its predecessor, it was written in FORTRAN, a popular, general purpose language, but one not specifically designed for simulation. The US Army Concepts Analysis Agency (CAA) acquired the COMMEL Model in the mid-1970s, installed it on a UNIVAC 1108 computer and extended its capabilities. This version, called COMMEL II.5, lacked capabilities deemed essential to realistically simulate many desired conditions. Some of these capabilities were codified into requirements and became part of the CAA prepared specifications and design logic for the DEWCOM Model along with the requirement to program the new model in the SIMSCRIPT II.5 language.

1.3 Comments on Modeling and Simulation

Most phenomena of the real world can, when taken individually, be described in the language of mathematics as a set of fixed relationships obeying the fundamental laws of nature or empirical approximations thereof. For example, the distance traveled by a body moving at a fixed velocity can be expressed as "distance = velocity x time." Another statement of relationship might be the "radius of damage of a nuclear

burst increases as the cube root of the yield." One can combine these two expressions to determine the amount of warning required by a person at desired ground zero (DGZ) of a nuclear device of given yield if he is to escape the blast by moving away from it at a given velocity. It is not necessary to actually explode weapons of various yields while people are driving away from DGZ at various speeds.

The development and use of a set of these abstract relationships to determine the outcome or the intermediate conditions of some collection of interacting real world phenomena is called "modeling," and the set itself is called a model. In the example above, if a number of weapons of various yields are exploded at various times and places over a large number of people in vehicles having different speeds, the computations become extremely tedious and complicated. The problem can best be resolved by transferring the computations to a large-scale computer which does the arithmetic at lightning speed, and can keep track in its memory of all the events as they occur. This, then, is called a "computerized model."

If, during the sequence of events in the above example, the drivers have opportunities to make choices depending upon their observation of the situation, these choices can be added to the model by inserting a set of logical rules into the list of instructions that the computer follows. For example, at any fork in the road, the vehicle takes that fork which leads most directly away from the most recent blast.

If there is a known probablility that a particular weapon will not fire, then over a large number of weapons, the performance of each individual weapon can be determined by the throw of dice. Suppose the chance of failure is one out of six. If the die comes up a six, for example, that weapon is said to fail. Such a procedure using random numbers instead of dice in the computer adds the capability of handling probabilistic processes in the model. Such a model is called a stochastic model.

A large and complex model, containing logic and probability, which runs on a computer from the initial conditions to completion without human intervention is usually called a simulation. This is a general term for the manipulation of the symbolic representation of a highly complex set of interacting events taking place over a period of time.

In order to simulate a particular real world activity, the mathematical expressions for the model must include all the factors significant to this activity and reflect faithfully their real life relationships. Moreover, in order that the model may be used more than once, these factors must be expressed so as to accept values of varying magnitudes for the many possible situations encountered in the real world activity.

2.0 THE DEWCOM MODEL

2.1 Model Overview

The DEWCOM Model is a two-sided, stochastic, combat simulation model which focuses upon tactical communications and electromagnetic intelligence/threat acquisition systems and the electronic warfare (EW) directed against those systems. The model is designed to simulate the concepts used in tactical combat, including communications-electronics and electronic warfare. It permits the analysis of current and future communications, radars, and electronic warfare systems and is structured in modular form so that specific aspects of electronic warfare against tactical emitters can be selected for analysis. The model is driven by a conventional tactical engagement between a Blue maneuver force and a Red maneuver force. Each side consists of realistically deployed ground and close air support forces that include maneuver units, EW units, artillery units, and support units. The tactical war is, in turn, driven

by a set of orders that may direct units to attack, defend, move, delay, or withdraw. As units take tactical actions, messages are triggered and then transmitted over explicitly modeled communication links. The successful completion of a message transmission is necessary for units to respond in the desired manner. Each side may conduct EW activities against the other side. Messages may be jammed or intercepted, the originator may be located, or no action at all may be taken. Radars may also be jammed and located. Intercepting messages or locating enemy radio transmitters increases a unit's level of intelligence of the opposing force. Intelligence is also gathered through direct observation of units in contact, surveillance radars, direction finders, and from message flow between units. Increases in intelligence can, in turn, cause messages to be generated which may be sensed by the enemy and/or acted upon by the intended recipient.

2.2 Model Methodology

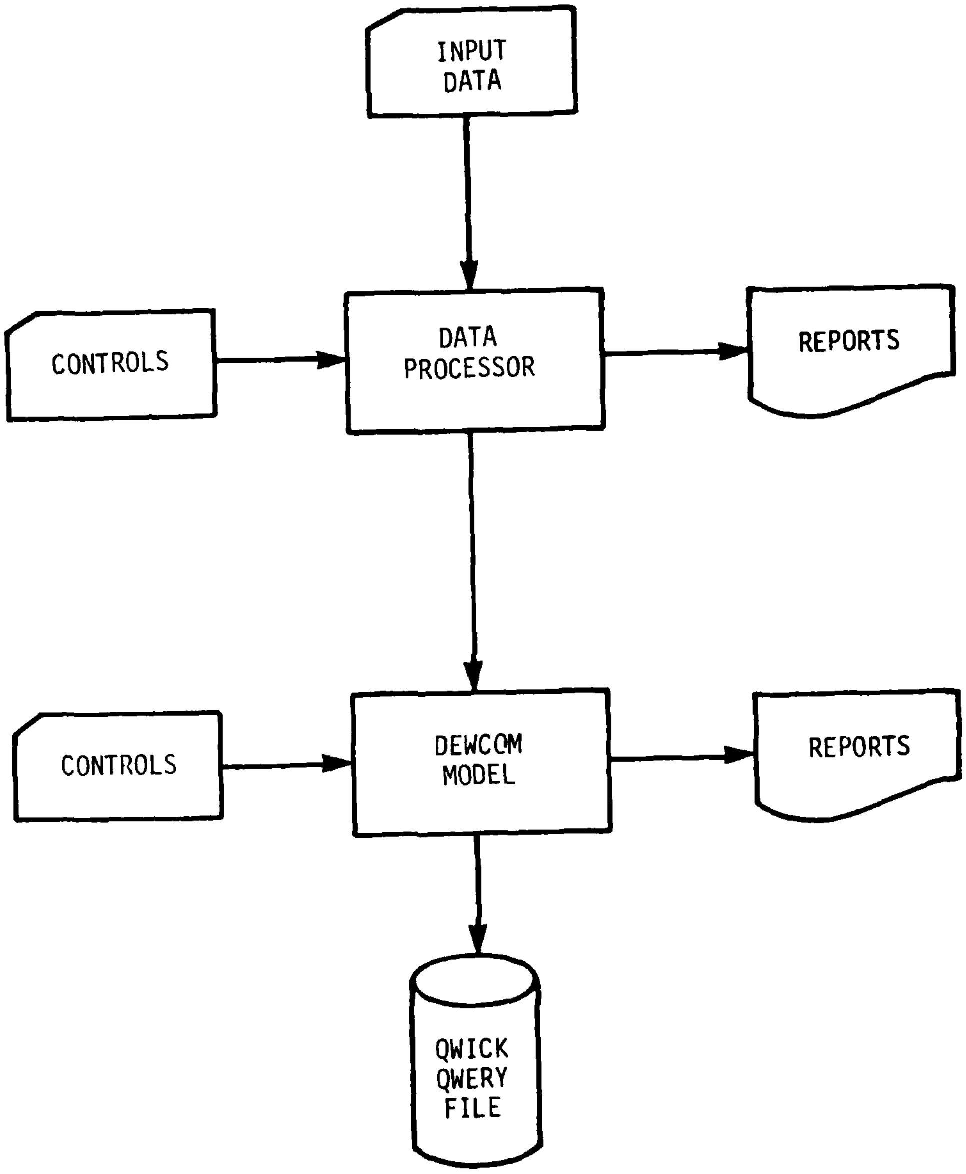
The overall DEWCOM methodology is reflected in the diagram on page 6 and consists of the following elements:

- The input data, prepared by the user, contains all the variable data concerning such factors as organization, equipment, communications, terrain, etc. to be modeled.

- The data processor and its user-specified controls builds the data set that drives the DEWCOM Model itself. The data processor performs certain input data verification functions by subjecting the data to reasonableness checks, builds the internal data structure from the user input, and produces reports based on the contents of the input data.

DEWCOM

METHODOLOGY



- The DEWCOM simulation itself, consisting of a large number of computer routines organized into several modules, simulates the passage of time and the multitude of interrelated processes occurring during the combat period. The model produces user-specified standard output reports and an output file from which the user can generate desired ad hoc reports.

- A QWICK QWERY post processor to generate one-time and special purpose (ad hoc) reports.

2.3 Model Design

2.3.1 Modules and Their General Functions

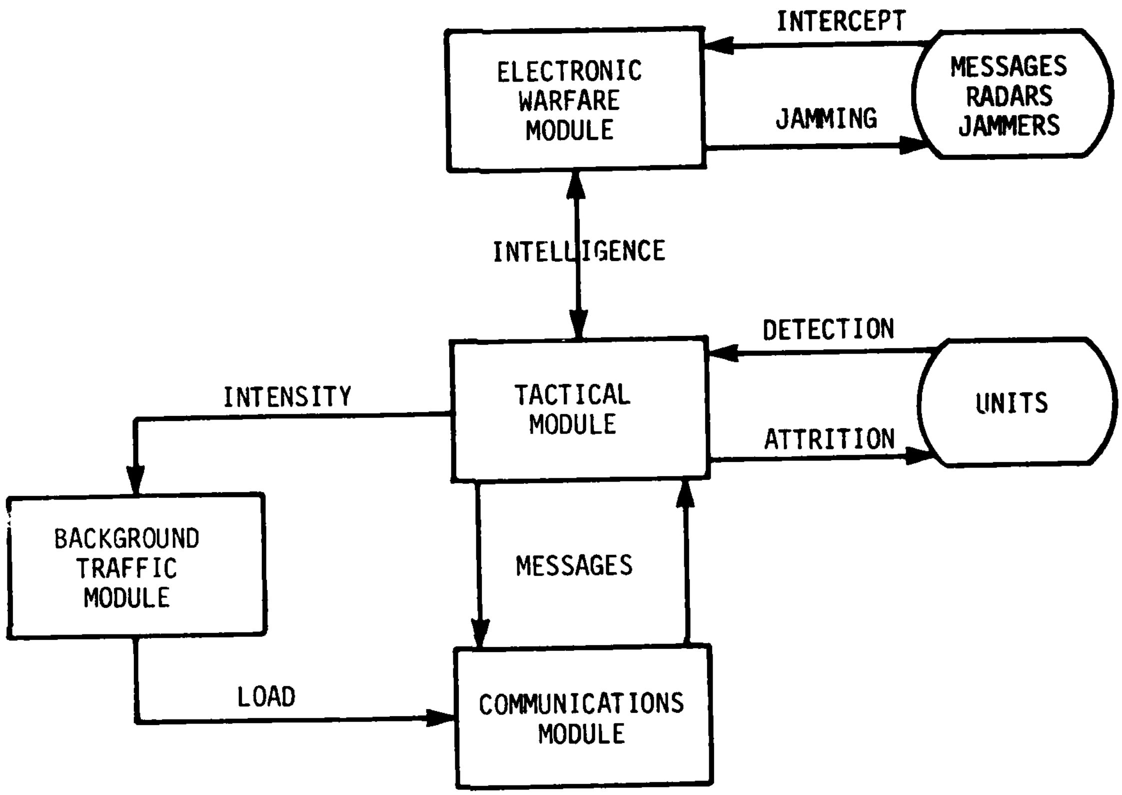
The DEWCOM Model consists of interrelated modules, as depicted in the diagram on page 8. The major functions of each module are as follows:

2.3.1.1 The Tactical Module

- Maneuvers units on the battleground
- Processes orders for each unit
- Fires weapons at opposing units and causes losses of personnel and equipment
- Causes explicit messages to be transmitted
- Maintains command structure
- Collects intelligence from sources other than radar

DEWCOM

MODEL STRUCTURE



2.3.1.2 The Communications Module

- o Processes and routes messages
- o Maintains status of communications facilities
- o Maintains communications structures

2.3.1.3 The Electronic Warfare Module

- o Intercepts enemy messages
- o Performs direction finding on enemy communications and radar emitters
- o Jams enemy communications, radars, and intercept equipments
- o Acquires communications intelligence
- o Acquires electronic intelligence

2.3.1.4 The Background Traffic Module

- o Reflects background message traffic implicitly
- o Increases/decreases the volume of background traffic in proportion to increases/decreases in the intensity of combat

2.3.2 Model Operations

A main program provides central control for the execution of the DEWCOM Model. The four model modules (noted above) are comprised of various subroutines to represent the following activities or functions occurring during the combat simulation:

- Unit movement is controlled by tactical orders. Three of the orders (attack, move, withdraw) cause a unit to move; two of the orders (defend, delay) describe the type action in which a unit is engaged when it is stationary. The unit moves until the desired distance (relating to an objective on the ground) is covered, and then it executes a new tactical order.

- Direct fire attrition is calculated by an aggregated "force on force" approach. As units are moved, they may come into contact with opposing units, causing attrition upon each other. Reduction in strength is a function of terrain, range, force ratio, and weapons. The loss of strength by a unit can cause a change in tactical orders. For example, a unit may change posture from "defend or delay" to "withdraw." Such a change could separate the opposing forces and cause direct fire attrition to stop.

- Indirect fire attrition is only applied when messages requesting such fire are received by the firing units. The routing of the message is determined by input data. Units generate requests for fire, the requests are communicated to firing units, and the missions are fired. A lethal area approach is used to calculate indirect fire attrition.

- Close air support may be requested by a message sent from units to the headquarters controlling air resources. If the

message is received, an air mission is ordered. If the communication fails because of jamming, the close air support mission is not initiated. For missions requiring ground coordination (user input), a subsequent message must be completed between a ground station and the aircraft before attrition can be applied. Losses incurred by sorties en-route to the target and over the target area are probability values entered as input parameters. Damage to the target when a sortie is successful is given as a percent of the target assets and is specified as an input parameter.

- Command and control is simulated in terms of tactical orders, communications orders, and EW orders. Possible tactical orders are attack, defend, delay, withdraw, move, and follow (i.e., use the orders of the superior unit). They provide each unit with a combat SOP. The communications orders, as the name suggests, involve commands from a superior unit to a subordinate unit via available communication channels. They include the tactical orders listed above as well as an order to jam enemy communications/electronics. Communications orders take precedence over the tactical order of the subordinate unit at the time of receipt of the message. Both tactical and communications orders are initiated when a preset threshold (e.g., local force ratio threshold, intelligence threshold, unit strength threshold, or time) is passed in the course of the simulation. The model simulates EW command and control by allowing each EW unit to execute primary and secondary options against specific enemy targets (viz., radio, radar, and EW equipment). The allowed options for EW activity in the DEWCOM Model are intercept, locate, barrage jam, and spot jam. Which order is executed is based on the type of target net and the distance of the target unit from the FEBA.

- Message processing is one of the most complex tasks performed by the model. This task takes the messages that are generated and routes them to the destination via links and nets defined by the input data. Message processing includes the delays that may occur for encrypting and decrypting, as well as those encountered when all available links are busy.

- Electronic warfare (EW) actions (direction finding, jamming, and interception) are all directed by a set of EW orders described by input data. Direction finding and interception result in an increase in intelligence about the opposing side. Jamming results in the enemy being denied use of communications and radar resources.

- Intelligence collection becomes the basis for many decisions in the model. Intelligence is gathered directly by:

  - units in contact with one another

  - direction finding

  - message interception

  - radar

  Intelligence also is gathered indirectly from messages that flow between units. Artillery fire can be ordered as a result of increased intelligence, and attrition on one side changes in accordance with the amount of knowledge about that side by the opposing side.

- Implicit message functions are modeled since it is virtually impossible (and in most cases, not desirable) to model every individual message that is transmitted among the units in

the simulation. For example, the delay time encountered by prioritized messages in the communications system may be increased as the amount of tactical activity increases.

- Radars of two kinds are simulated in the model: counterbattery and surveillance/target acquisition. Counterbattery radars react to artillery fire and can gain intelligence about the firing unit. The surveillance/target acquisition radars gather intelligence about the opposing units within range and line of sight.

- Terrain is taken into account by the use of two terrain models. The first model describes each grid square of the terrain with parameters affecting movement rates. The second model provides a basis for the calculation of optical line of sight between any two points on the battlefield. The line-of-sight routine is employed to determine if units can engage opposing units using direct fire weapons and also to determine radio line of sight. The signal loss for electronic transmission is based on the existence (or absence) of visual line of sight.

2.4 Model Stop/Restart Feature

The model can be stopped, have data changed, and be restarted from the point where it stopped. This permits changing tactics in the middle of a battle. It also allows the data that describe weapon performance to be changed. The change of tactics might be employed, for example, to model a commander declaring radio silence at some time. The change of the weapons data might be used to model a change in the environment such as the employment of smoke (or, perhaps, nuclear effects).

2.5 Sizing of Basic Parameters

For the purpose of developing the DEWCOM Model, size considerations came into play for certain basic parameters. In general, the number of communications nets increases with the size of the echelon. Communications arrays and nets for US and potential threat forces used as a guide for sizing the model were based on a US division with corps assets facing a Soviet combined arms army with front assets. Since future systems which might require modeling may be structured in a much different manner, flexibility in the manner in which nets are depicted is incorporated in the model.

2.6 Time and Memory Requirements

The developmental work on DEWCOM was carried out on an IBM 370/148 computer system and subsequently adapted and satisfactorily checked for operation on the CAA UNIVAC 1108. With proper specification, it is capable of being operated on most large-scale computer systems on which the SIMSCRIPT II.5 compiler has been installed.

The simulation of a Blue brigade against a Red division requires 210K words on the UNIVAC 1100/82 and takes approximately 40 minutes of computer time to simulate 8 hours of combat. The time and computer memory requirements for operation of the DEWCOM Model are highly dependent on the size of the simulation to be run.

3.0 INPUT DATA

3.1 General Description

The DEWCOM Model is driven by data supplied by the user, describing the characteristics and conditions of the forces involved in the simulated combat. The input data are identified by English-like keywords, making them more meaningful and manageable when being prepared, modified, and verified. The data are structured for minimal repetition. For example, it is necessary to enter the characterisitcs of a radio only once rather than for every unit that has one. Built into the model are verification checks which look for "reasonableness" of the data. For example, probability values should be in the range of zero to one. The model does not stop when an "out of bounds" value occurs, but issues a warning notice to the user and continues.

3.2 User Control

The control available to the user of the DEWCOM Model is substantial, since the data set to run the model is input rather than imbedded in the code. This control ranges from the selection of input data to the selection of reports to be generated from the model. User ability to direct the forces for either side through input is extremely flexible.

3.3 Input Data Organization

The input data set is organized into the following major categories:

- o Controls
- o Terrain

- o Equipment
- o Type Units
- o Combat Organization
- o Communications Organization
- o Orders

The first category (Controls) is concerned with the general overall operation of the model. Through it, the user identifies reports to be produced from the simulation, lists variables which do not apply exclusively to one side or the other, and otherwise establishes the general parameters for a particular "run" of the model.

The remaining six categories describe specific characteristics, capabilities, and conditions of the opposing forces being modeled, such as units, weapons, organization, combat posture, tactics, etc. and the terrain on which the simulated combat takes place. The basic building block for the forces in the model is the unit. Each unit is given a data structure so that any unit found in military organizations can be described. Units are organized in a "tree" structure to allow complete freedom in describing the command structure.

3.4 Input Data Preparation

Special forms (Input Data Preparation Forms) have been designed to simplify the coding of data for input to the DEWCOM Model. The numbering of forms by and within major data categories permits them to be readily maintained in the proper entry sequence. Where necessary, multiple copies of a specific form can be used by lining out inapplicable key

words and data fields. Detailed instructions for the forms are contained in the DEWCOM User Manual.

4.0 REPORTS

The products available from the DEWCOM Model are divided into three major report categories:

- o Input Data Reports
- o Model Reports
- o Ad Hoc Reports

The generation of any or all of the reports is at the option of the user.

4.1 Input Data Reports

Input data reports provide the user with formatted listings reflecting actual data which was input to the model for the current run. The full simulation need not be run in order to produce these reports. In fact, one of their major uses is to permit a review of the input data for errors or omissions before a simulation run is actually made.

The production of the Input Data Reports is controlled by the user at input time through entries in one of the special DEWCOM Input Data Preparation Forms. The individual reports and their content are explained in the DEWCOM User Manual, and a sample of each report format is included in that document.

4.2 Model Reports

Model reports provide the user with the status of various model factors reflecting the effects of the simulation. The reports reflect the model status at the beginning of the simulation, at intervals specified by the user at input time, and at normal termination of the simulation.

Production of the Model Reports is controlled by the user at input time through entries on the appropriate DEWCOM Input Data Preparation Form. The desired reports are produced at the interval specified by the user, and the simulated time is reflected on each. A sample of each report format is included in the DEWCOM User Manual.

4.3 Ad Hoc Reports

Provision is made for special or one-time reports to be produced from the DEWCOM Model using the QWICK QWERY Processor. QWICK QWERY is a data analysis and report generation system created to selectively access and display information from existing data files. It provides for different report formats, sorting sequences, attribute selections, and subtotals which are conveniently produced as needed.

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